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INDUSTRIAL APPLICATION OF TAPIOCA (CASSAVA)
FOR MANUFACTURING OF TAPIOCA MACARONI
OR TAPIOCA RICE

By H. KOLB,
Uzwil, Switzerland

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NOTES

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Industrial application of Tapioca (Cassava) for manufacturing of

Tapioca Macaroni or Tapioca Rice

by: H. Kolb, Uzwil, Switzerland

a) Remarks of scientific development and justification in relation of the nutrition

The Indian national leaders as also Government authorities are anxious that the country should not only produce more foodgrains but also make better use of various other forms of food materials that are nutritionally valuable but have not yet been adequately utilised. There are also certain high yielding crops, which, if produced on a larger scale and properly utilised can help to cover the present deficiency.

The General Food Technological Research Institute, during its twelve years of existence, has made important contributions both in regard to more efficient utilisation of the present resources and in the introduction of different types of foodstuffs so far untried by the Indian people. It must be appreciated, however, that the popularisation of such foods presents sociological problems that are fundamental and become quite as important as the scientific and technological work leading to the production of such foods.

The development of Tapioca Macaroni by the Central Food Technological Research Institute and a Swiss manufacturer is a significant accomplishment of concerted effort in the production of a clean, wholesome article of food. Both quantitatively and qualitatively it satisfies scientific standards and technological requirements. The widespread public acceptance of the product (by the rather critical consumers) in the populous state of Kerala encourages us to believe that an important battle is being won and that with further efforts, it will be possible to popularise and to extend the production to other parts of the country.

Tapioca is a root crop (Cassava Manihot utilisima) which yields several times as much starchy food per acre as the cereal crops, (e.g. 3 - 4 times) and require more attention. By itself, Tapioca is an incomplete food, and needs to be enriched with body-building proteins. To produce the desired composition, small percentage of specially prepared groundnut flour and wheat semolina (Soji) have been added to Tapioca flour and the mixture scientifically processed so as to yield products which can be cooked and consumed in the same or similar way as foodgrains or standard Macaroni products.

After years of intensive research at the Central Food Technological Research Institute, Mysore and the Swiss Manufacturer's Laboratory, Tapioca Macaroni is now made up of 60 parts of Tapioca flour, 15 parts of specially processed groundnut flour and 25 parts of wheat semolina or soji. The pilot plant for its manufacture at the Central Food Technological Research Institute, Mysore, has a capacity of two tons a day.

The resulting product contains about 10% protein, twice as much as rice, besides the requisite quantities of minerals and vitamins. Tapioca Macaroni, this low-cost and nutritious new staplefood is wholesome and contains no dirt, stone or other foreign matter.

It cooks within five or eight minutes as compared to rice which takes nearly half an hour.

The basic technique of cooking Tapioca Macaroni is as follows: Six cups of water will be used for each cup of Macaroni. The water has to be brought to a vigorous boil, the Tapioca Macaroni afterwards dropped gradually into the vigorously boiling water and stirred, they will be cooked within five or eight minutes. After draining the gruel, the cooked Tapioca Macaroni may be used in the same way as rice or for the preparation of different dishes.

Part extract of the booklet: Tapioca Macaroni goes to people

b) The Preparation of the Raw Material

1) Tapioca flour

It is prepared from white, dry chips obtained from the Tapioca tuber after removing both its outer skin and the inner rind.

Tubers are rich in starch and contain adequate quantities of minerals like calcium, but are very deficient in protein, as the following composition of fresh Tapioca tubers will illustrate:

- Moisture	59,4%	Phosphorus	0,04%
- Protein	0,7%	Iron	0,9 mg
- Fat	0,2%	Vitamin B	0,045 mg
- Mineral matter	1,0%	Nicotinic Acid	0,7 mg
- Carbohydrate (Starch)	38,7%	Riboflavin	0,04 mg
- Calcium	0,05%	Vitamin C	0,24 mg

Great care should be exercised in drying Tapioca chips so as to avoid contamination with dust. The drying has also to be done quickly to avoid fungal growth which introduces undesirable flavour and also otherwise affects the quality of the finished products.

The complete grinding unit comprises a disintegrator such as a hammer mill along with other accessories like a feed device for chips, a magnetic separator, a pneumatic conveying system with cyclone, a sifter and, for collecting dusty air an effective filter section with blower. Storage silos for chips and Tapioca flour so as a suitable arrangement for bagging the flour must be provided. The Swiss Manufacturer disposes of great experience in the field of grinding seeds, cereals and similar and would therefore be pleased in submitting modern propositions together with plans and quotation.

The degree of fineness of the flour is such that about 60% of it has a particle size ranging between 30 - 60 mesh and 40% passes through 60 mesh.

2) Groundnut flour

The damaged and shrivelled kernels of the decorticated groundnuts as obtained from the decorticating machine so as grit and stones etc. are sorted out by means of a shaker fitted with sieves of different mesh size. This separation is based on size grading. The clean kernels are given a light roast in a roaster of the type used for roasting coffee or cocoa beans. The heated kernels are then cooled and the red cuticle removed by mechanical scrubbing in a blanching equipment similar to one used in the manufacture of peanut butter.

The detached cuticle and the germ are separated out by a current of air. It is very necessary to remove the cuticle as, otherwise, it will impair the colour of the flour and also the final product. Great care should be taken to avoid contamination of the kernels with any grit or sand. The decuticled kernels are re-examined for removing any residual defective pieces. The clean kernels are then pressed in a conventional oil-expeller to obtain oil and press-cakes containing the minimum amount of residual oil (max. 5 - 6%). The humidity content is about 8%. The press-cake is ground in a hammer mill and flour with such a degree of fineness as would allow 95 percent of it to pass through 22 mesh, is obtained. The type of flour used contains nearly 50% protein. It is not desirable to store the groundnut flour for long and therefore it should be a normal practice to grind only a week's requirement at a time.

Oil-seed preparation and pressing is also a speciality of the same Swiss Manufacturer. Diagrams, plans and quotation for large and small plants are available on request.

Note: Tapioca chips and groundnut cake have different grinding characteristics and have therefore to be ground separately.

3) Wheat semolina (soji)

The wheat is to be milled in such a degree of fineness that 100 percent pass through 32 mesh. The Swiss Manufacturer is since 100 years builder of roller mills and are prepared to quote for soft and hard wheat, and for any desired capacity.

c) Dry Mixing of Ingredients

A substantial part of the Tapioca Macaroni plant consists in the blending and mixing arrangement.

Bins of adequate size must be provided in order to supply the productions unit (4) with sufficient raw material. The stocking facilities for Tapioca flour, groundnut flour and wheat flour should accommodate at least the necessary quantity for running the plant about 2 days at full capacity.

The raw materials are received in paper or jute bags at about 100 lbs. One to two men pour the flour in a feed hopper with a built-in shaking sieve. A fluidlift (pneumatic transport) with a capacity of 7,5 to/h lifts the raw material up to the top of the 3 silos which are aspirated. The advantages of fluidlift- transports are numerous: Pipes require little space - good

aeration of product - different products can be conveyed one after the other since the pipes empty completely - pneumatic conveying is sanitary, no possibility of infestation.

Each storage bin is fitted with a suitable extraction apparatus which itself feeds an automatically working balance. An electric control panel controls the present number of weighings. For each product such a unit is provided. The blend proportion is therefore easily adjustable.

The simultaneously weight mix components come either by gravity or another fluidlift to the mixing unit. For plants with a capacity up to about 15 to 24 h a vertical conical mixer fitted with a central mixing worm can be used. For bigger plants a rapid batch mixer with a horizontal stirring worm is recommended, the total weight per batch is between 700 and 1000 kgs. The necessary mixing time is about 45 to 60 minutes, in a vertical mixer 4 to 10 minutes only, in a rapid batch mixer.

The raw materials are blended in the following proportion: Tapioca flour 60% groundnut flour 15% and wheat 25%. The average moisture content of the ready mix is 10 to 11% of which about 1,1 tons are necessary to produce 1 ton of finished Tapioca Macaroni.

From the mixer unit the homogeneous blend is then pneumatically conveyed to the feed hopper(s) above the press(es). The Tapioca Macaroni blend is not an easily flowing product and therefore it is recommended to arrange the hopper(s) with an accurate stirring device.

Should the condition of the raw material demand it, an efficient arrangement to kill insects and insects' eggs would have to be provided just before or right after the mixer.

d) Production of Tapioca Macaroni

A complete continuous production line consists of:

- 1) An extrusion press, comprising:
 - a dosing apparatus for raw material mix and boiling water.
 - a continuous working mixer with vacuum device.
 - a press unit, existing of press worm and press cylinder, the latter being of special design for heat treatment of the dough.
 - a presshead to take up a circular die.
 - a cutting apparatus.
 - a fan and various motors, a vacuum pump and an electric control board.

The raw material blend is mechanically mixed with boiling water in the proportion 100:40. The mixing and kneading time is about 20 to 25 minutes. Before the pressing process the ready dough is evacuated from air at 80 to 90% vacuum. During pressing the dough undergoes a special heat treatment. At about 70°C the starch begins to gelatinize. Due to this procedure the end product becomes hard and excellent cooking and eating qualities so as an improved shelf life.

The main parts of the extrusion press being in contact with the dough are made of stainless steel or rust proof material. The dies are made of bronze or stainless steel and according to their performance they permit to produce short tubes, shells, rice, grains etc.

2) A predryer

of the shaking type, made of a metal framework, panelled with aluminium sheets. Built-in are five oscillating sieves, fans and drive parts with motors.

The cut Tapioca Macaroni fall from the die directly on the top sieve and within 4 to 7 minutes it passes over each sieve. During this time it is intensively ventilated with hot air and gets in this way a superficial drying and an additional heat treatment. The total moisture decrease of the product is 1,5 to 2,5% which is enough to prevent the product from sticking together. It can now easily be handled by an inclined belt conveyor and the following belt dryers.

3) A belt drying unit

- which consists principally of two independent sections of different length and with different drying cycles. The first dryer has 7 belts, the second only 5. Each dryer consists of:
- a metal framework (block system) standing on adjustable legs and covered with heat and steam resisting panelling.
 - 7 respectively 5 belts made of patented S-shaped aluminium channels.
 - an oscillating distributor on top of the dryer.
 - a discharge shaker.
 - a number of fans, motors, reduction gears and various other drive parts.
 - an electric switch board and a temperature control.

The product remains about 40 minutes in the first and passes in approx. 8 hours the second dryer. During drying the product is evenly ventilated with warm air of low psychromatic difference. Temperature and relative humidity of the drying air in the various zones of the dryers must be regulated according a prefixed diagram. The necessary arrangements for this regulation are provided in the dryers. When passing the dryers the goods are several times unloaded which is essential for even drying. The goods leaving the last dryer have a moisture content of about 10 to 11%.

e) Nutritive value, ingredients and shapes of product

The process for the preparation of Tapioca Macaroni products uses as is now known a blend of 60 parts of Tapioca flour, 15 parts of specially processed low fat groundnut flour and 25 parts of wheat semolina so as boiling water.

To make it psychologically more acceptable, the Tapioca Macaroni was until now produced in the shape of rice, small tubes and shells.

The nutritive value of Tapioca is about twice as high as of natural rice. The composition is as follows:

Moisture	11,0%
Protein	10,5%
Fat	1,9%
Ash	1,8%
Fibre	0,7%
Carbohydrates (by difference)	73,8%
Calcium	0,05%
Phosphorus	0,14%
Iron	2,90 mg/100 gr
Thiamine	0,22 mg/100 gr
Nicotinic Acid	3,70 mg/100 gr
Riboflavin	0,07 mg/100 gr

It is an important fact that Tapioca Macaroni products contain large quantities of protein, calcium and vitamins.

Unlike naturally grown grains as rice, wheat etc., Tapioca Macaroni is an extremely clean product. It doesn't contain any foreign matter and is 100% food. It is not required any washing before cooking. The staple food Tapioca Macaroni has the advantage that it cooks within 5 to 8 minutes. Tapioca Macaroni is easily digestible and will benefit particularly growing children.

And never forget that 75% of the raw material used for the preparation of this new and very nutritious staplefood is produced by indigenous agriculture.



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The resulting product contains about 10% protein, twice as much as rice, besides the requisite quantities of minerals and vitamins. Tapioca Macaroni, this low-cost and nutritious new staple food is wholesome and contains no dirt, stone or other foreign matter.

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1. Les mémoires choisis pour être présentés en séance générale pourront être obtenus à la Conférence dans les langues officielles suivantes des Nations Unies: anglais, espagnol, français et russe.

2. Les mémoires choisis pour être présentés en séance spéciale pourront être obtenus à la Conférence dans l'une seulement de ces langues officielles.

3. Les résumés qui ont été rédigés pour tous les mémoires par les auteurs de ceux-ci pourront être obtenus à la Conférence dans les langues officielles suivantes des Nations Unies: anglais, espagnol, français et russe.

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LA PISCICULTURE DANS LES REGIONS TROPICALES

par Marcel HUET (Bruxelles, Belgique)

Directeur de la Station de Recherches des Eaux et Forêts
Professeur extraordinaire à l'Université de Louvain

1. Le poisson joue un rôle considérable dans l'alimentation des populations des régions tropicales. En général ces populations souffrent d'un déficit alimentaire en protéines d'origine animale. Depuis des siècles, la pisciculture en étangs est en honneur en Extrême-Orient en vue de produire du poisson de consommation. Elle est beaucoup plus récente dans les régions tropicales d'Afrique et d'Amérique centrale et du sud où, en fait, son expansion véritable date d'une quinzaine d'années seulement. La présente note, forcément très succincte, donne un bref aperçu de la pisciculture dans les régions tropicales d'Extrême-Orient et d'Afrique centrale et formule ensuite quelques recommandations d'ordre général.

a) La pisciculture en Extrême-Orient.

2. ~~ix~~ Les caractères essentiels de celle-ci sont donnés en prenant comme référence l'Indonésie. En 1954, la production de poisson de mer et d'eau douce y était de 612.000 tonnes, ce qui représente une consommation annuelle moyenne d'environ 8 kilos par habitant. On vise à porter la production et la consommation à 20 kilos. La pêche en mer fournit plus de 60% de cette production; le reste est produit par les eaux continentales: pêche en eaux libres (lacs, eaux courantes) et pisciculture en eaux fermées (29.000 t. en étangs d'eau saumâtre, 24.000 t en étangs d'eau douce, 9.000 t en rizières).

1) La pisciculture en "tambaks" ou étangs d'eau saumâtre.

3. Les étangs d'eau saumâtre sont abondants en Extrême-Orient, particulièrement en Indonésie et aux Philippines. En Indonésie, selon les données de 1954, ils couvrent 128.000 hectares et produisent 226 kilos à l'hectare.

4. La principale production piscicole des tambaks est celle du Chanos chanos, Clupéide marin appelé "milkfish" en anglais. Ce poisson marin grandit remarquablement bien dans les tambaks

mais ne se reproduit pas en captivité, aussi les alevins doivent-ils être pêchés en mer et transférés en étangs. Ils y grandissent rapidement et, en 8 à 10 mois, atteignent un poids de 250 à 500 grammes.

5. Les alevins sont capturés le long des côtes sableuses, plates, à eaux claires, entreposés dans des bidons circulaires plats, et acheminés vers leurs lieux de destination, parfois fort éloignés. La stabulation et le transport peuvent durer dix jours.

6. Les jeunes Chanos sont d'abord déversés en étangs d'alevinage où ils demeurent environ un mois. Ils passent ensuite dans les étangs de croissance. Les tambaks sont alimentés en eau à la fois par la mer et, habituellement, par un cours d'eau. Les mouvements d'eau se font en liaison avec la marée. La salinité de l'eau des tambaks est très variable.

7. La production des tambaks en Chanos est comprise entre 40 à 80 kilos à l'hectare et par an dans les tambaks à sol pauvre et entre 200 à 400 kilos dans les sols riches. Aux Philippines, la production est nettement plus élevée. Elle atteint 1.000 à 2.000 kilos, mais les poissons sont nourris artificiellement.

11) La pisciculture en étangs d'eau douce.

8. Les principaux poissons élevés en étangs d'eau douce en Indonésie sont, par ordre d'importance: Cyprinus carpio (+ de 50%), Tilapia mossambica, Puntius javanicus, Helostoma temminckii, Osteochilus hasselti, Osphronemus goramy, Trichogaster pectoralis, espèces diverses.

9. La Carpe commune est le principal poisson d'élevage en étangs d'eau douce et en rizières. La Carpe cultivée en Extrême-Orient est une forme à écailles, de coloration variable. Elle supporte bien les températures élevées et peut se reproduire tous les trois mois. Diverses méthodes de reproduction sont utilisées, dont la principale est celle des Iles de la Sonde qui utilise des frayères artificielles en fibres végétales appelées "kakabans" dans les étangs de ponte et d'éclosion. On vise à produire en trois mois un poisson de consommation de 15 à 20 cm pesant 75 à 100 gr.

10. Parmi les autres espèces de poissons, il faut mentionner: le Puntius javanicus, à croissance assez rapide et qui se nourrit en partie de végétaux submergés et d'algues filamenteuses; le Gouramy, poisson végétarien, à chair excellente et très fine, mais peu prolifique et à croissance lente dans le jeune âge; le Tilapia mossambica, découvert fortuitement à Java en 1939 et dont l'introduction et l'élevage dans divers types d'eaux continentales sont considérés comme un succès. En Extrême-Orient, on élève fréquemment en étangs les Carpes chinoises, principalement Ctenopharyngodon idellus, poisson végétarien d'excellente croissance. On élève encore de nombreuses autres espèces, par exemple le Pangasius pangasius en Thaïlande, qui peut se nourrir directement de déjections animales.

11. En règle générale, l'alimentation artificielle n'est pas très intensément utilisée, mais la fumure est largement em-

ployé, principalement sous forme de fumure organique. La plus communément utilisée est fournie par les matières fécales humaines et animales. Les productions sont relativement élevées, du fait de la richesse naturelle des eaux et de l'enrichissement par fumure. En Indonésie, en 1954, la production annuelle moyenne était de 1.181 kilos à l'hectare, mais elle atteint 2 à 5 tonnes à l'ha dans les étangs de Bandung fortement enrichis par les eaux d'égouts.

iii) La pisciculture en rizières.

12. Elle joue un rôle important dans les activités piscicoles d'Extrême-Orient. L'un des facteurs qui en limite le développement est le débit d'eau; il faut au moins de 1 à 2,5 litres d'eau à la seconde à l'hectare.

13. La Carpe est le principal poisson élevé en rizières. On y associe parfois d'autres poissons, notamment le Tilapia mossambica.

14. Diverses méthodes de pisciculture sont en usage dans les rizières. Selon les unes, on élève successivement et alternativement le riz et le poisson, ce dernier entre deux cultures de riz (une culture de riz et une culture de poisson par an ou bien trois cultures en deux ans). On cultive aussi en même temps riz et poisson. Chacune de ces méthodes peut être orientée soit vers la production de fingerlings, à partir du petit alevin, soit vers la production de poisson de consommation, à partir du fingerling.

15. La production des rizières en poisson est très variable. Ramenée à l'hectare et par an, la production est comprise entre 600 et 800 kilos pour les méthodes où culture de riz et de poisson alternent et elle est voisine de 300 kilos dans la méthode d'élevage où l'on combine riz et poisson. Mais comme la période de production est toujours inférieure à un an, en réalité la production annuelle moyenne des rizières d'Indonésie était évaluée à 139 kilos à l'hectare en 1954.

b) La pisciculture en Afrique Centrale.

16. Le véritable développement de cette pisciculture coïncide avec l'activité de la Mission piscicole du Katanga, en 1946-47. Elle chercha à développer la pisciculture en étangs pour l'alimentation des populations africaines et publia ses premières directives pour cet élevage en 1948. La pisciculture se répandit rapidement au Congo Belge, au Cameroun, au Moyen-Congo, ainsi qu'en de nombreux autres territoires d'Afrique Centrale, pour gagner l'Ouganda en 1958. Des Conférences internationales réunissaient les spécialistes intéressés à Elisabethville (1949), Entebbe (1952), Brazzaville (1956), Lusaka (1960).

17. Jusqu'à présent, la pisciculture en Afrique Centrale est principalement basée sur l'utilisation du Tilapia. La Mission piscicole du Katanga découvrit deux espèces T. macrochir et T. melanopleura et elles furent largement propagées au départ d'Elisabethville. Le grand avantage des Tilapia est qu'ils se reprodui-

sent très aisément en étangs et qu'ils acceptent le nourrissage sans difficulté. Ils sont capables de tirer un excellent parti de nombreux aliments végétaux, de farineux et de déchets divers. Les végétaux sont spécialement intéressants pour les Tilapia herbivores (feuilles de manioc, de patate douce, de colocas, de bananier et herbages divers). Les farineux conviennent à toutes les espèces (déchets de meunerie en général, spécialement le son et la farine de manioc, les brisures et balles de riz, les farines et son de maïs, les tourteaux ~~et~~ coton et d'arachide). Les déchets les plus divers, de ménage, de fabrication de bières indigènes, les fruits pourris, les drèches de brasserie, les pulpes de café, sont utilisables. Ce qui n'est pas consommé comme tel tombe sur le fond, s'y décompose et joue le rôle de fumure organique.

18. D'autres Tilapia que les deux précitées ont été utilisés avec succès, notamment le T. zillii parmi les phytophages et, parmi les microphages-omni-voraces, les T. nilotica, galilaea, mosambica, andersonii, nigra. Cependant, beaucoup de confusion et d'incertitude règnent encore. L'étude systématique et biologique complète de ce genre devrait être faite afin de mettre au point la classification, la distribution géographique et la biologie des nombreuses espèces, races, variétés et formes géographiques qu'il comporte. On pourrait ~~donc~~ ^{avec} utiliser dans chaque pays, dans chaque région, les Tilapia les mieux adaptés aux conditions locales.

19. En dehors de la pisciculture des Tilapia, on a tenté ^{avec} des succès divers et souvent assez faibles, la pisciculture d'autres Cichlidae (Tylochromis, Hemichromis, Serranochromis), Cyprinidae (Barbus, Labeo), Citharinidae, Clariidae. Des résultats ~~pas~~ encourageant ont été obtenus avec un Osteoglossidae: Heterotis niloticus, dont l'élevage est pratiqué en République Centrafricaine et au Cameroun. A l'heure actuelle, on n'a pas enregistré d'excellent résultat après l'essai de poissons originaires d'Europe, d'Extrême-Orient ou d'Amérique du Nord.

20. Les méthodes de pisciculture utilisées jusqu'à présent sont fort empiriques. Selon les unes, on sépare les classes d'âges, selon les autres, les âges sont plus ou moins mélangés. Les mises en charge sont très variables et on a recours, selon les cas, à une ou plusieurs espèces. Selon le pisciculteur, les poissons sont parfois nourris abondamment, mais aussi parfois très peu ou pas du tout. La durée d'exploitation est très variable et la récolte est précédée ou non de pêches intermédiaires. Par suite de défauts dans la construction et l'aménagement des étangs, la mise à sec complète des étangs est souvent difficile ou parfois même impossible. Dans de telles conditions d'exploitation, les productions sont très variables en quantités et en qualité. En quantité, on peut arriver à produire, dans les meilleures conditions, plusieurs tonnes (jusqu'à dix tonnes) à l'hectare et par an tandis que les exploitations médiocres peuvent ne produire que quelques dizaines de kilos. Au point de vue de la qualité, la production est souvent formée d'un mélange de tailles avec dominance de petits poissons.

21. En règle générale, on continue à produire des poissons d'âge et de tailles mélangés. La mise en charge est formée de poissons de toutes tailles, de l'alevin au reproducteur. A la

vidange on conserve une partie de la récolte pour rempoissoner. Cette méthode, à la portée de tout pisciculteur, produit des poissons de tailles mélangées dans lesquelles prédominent les sujets de petite dimension.

22. Il est difficile de produire des Tilapia calibrés car ces poissons se reproduisent prématurément. Diverses méthodes, faisant appel à plusieurs catégories d'étangs, peuvent être utilisées pour produire des poissons calibrés. En Israël et en Malaisie, on a recours à deux catégories d'étangs. La méthode donne satisfaction. D'autres méthodes sont utilisables, mais les résultats ne peuvent pas être considérés comme définitifs. Ainsi par exemple on peut recourir à la monosexulture, à l'hybridation interspécifique (des résultats très intéressants ont été obtenus en Malaisie avec deux races de Tilapia mossambica), à l'élevage simultané de Tilapia et d'un prédateur (à ce jour c'est l'élevage avec Hemichromis fasciatus qui a donné les meilleurs résultats).

23. Le développement de la pisciculture africaine est freiné du fait que le paysan africain s'est montré capable d'un effort discontinu pour établir son étang de pisciculture mais répu- gne à l'effort continu requis par l'alimentation journalière des étangs de son exploitation.

c) Recommandations générales relatives
à la pisciculture tropicale dans les étangs d'eau douce.

24. Les présentes recommandations ne visent pas la pisciculture dans les eaux saumâtres et dans les rizières.

25. L'élevage de poissons en étangs d'eau douce peut prendre le caractère d'un élevage ~~rural (familial ou artisanal)~~ à caractère rural (familial ou artisanal) ou celui d'un élevage à caractère commercial ou à caractère industriel. Les élevages à caractère commercial cherchent à produire des alevins de repeuplement ou des poissons de consommation ou bien encore, simultanément, des alevins et des poissons de consommation. Les élevages ruraux, à caractère familial ou à caractère artisanal, visent à produire du poisson destiné au producteur lui-même et à sa famille ainsi que, éventuellement, un supplément destiné à la vente dans le milieu rural habité par le producteur.

26. Les élevages à caractère commercial ou à caractère industriel visent à produire des quantités importantes de poissons. Ces élevages doivent se pratiquer dans des étangs d'assez grandes superficies. On vise aussi à y intensifier la production soit par fumure, soit par alimentation artificielle. La fumure est surtout utilisée en Extrême-Orient, où l'on a recours principalement à la fumure organique, mais des résultats très intéressants ont été enregistrés en Malaisie par l'emploi d'une fumure minérale phosphatée. L'alimentation artificielle n'est intéressante que si elle peut se faire à des conditions économiques. Ce peut être le cas si la pisciculture est incorporée à une industrie agricole qui fournit le sous-produit: minoterie, brasserie, rize-

rie, ou annexée à une ferme maraîchère ou de petit élevage, ou de nombreux déchets peuvent être avantageusement transformés en poisson.

27. Les élevages à caractère familial ou à caractère artisanal se pratiquent dans des étangs de petite superficie. Pour que ces élevages soient réellement intéressants, il importe que la production y soit intensifiée. On doit viser à produire 20 à 30 kilos de poisson à l'are, ce qui n'est réalisable que par application d'une fumure importante ou d'une alimentation artificielle intensifiée. La fumure organique est d'usage courant en Extrême-Orient où les latrines surplombent souvent l'étang, tandis que la basse-cour et les étables sont en bordure immédiate des étangs. Ces pratiques ne sont pas d'usage en Afrique, mais l'intensification de la production pourrait être obtenue en distribuant une nourriture artificielle aussi abondante que possible: déchets de ménage, végétaux et farineux divers. Mais une telle pratique n'est possible que si les étangs sont à proximité immédiate de l'habitation du pisciculteur. Or ce dernier point de vue a souvent été perdu de vue en Afrique où les étangs familiaux ont trop fréquemment été construits à des distances considérables des villages.

28. Pour obtenir une production élevée, il est souhaitable que la population des étangs soit formée d'un mélange d'espèces ayant des régimes alimentaires différents. L'élevage simultané de plusieurs espèces est, depuis longtemps, largement en usage en Extrême-Orient. En Afrique, on a surtout fait l'élevage de deux *Tilapia* à régimes alimentaires différents, ainsi que l'élevage simultané de plusieurs classes d'âges. De nouvelles formules de mélange pourront certainement être développées à l'avenir.

29. Enfin, il est souhaitable que les étangs d'élevage ne soient pas trop profonds. Certes il est souhaitable que la profondeur soit suffisante sinon on risque de voir s'installer une végétation verticale indésirable. Mais il n'y a pas d'avantage à adopter une trop grande profondeur car cela contrarierait spécialement la pratique des pêches intermédiaires à la seine ou au lâtis de bambou. Une bonne profondeur moyenne est voisine de un mètre ou légèrement inférieure.

30. Ainsi conçue, la pisciculture d'eau douce doit être regardée comme l'un des plus importants facteurs de l'économie rurale et l'une des plus importantes sources de protéines animales dans l'alimentation des populations rurales.

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SUMMARY

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Belgium

FISHBREEDING IN TROPICAL REGIONS

By Marcel HUET,
Brussels, Belgium

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FISHBREEDING IN TROPICAL REGIONS.

1. Fishing-breeding in soft water must be regarded as one of the most important factors of rural economy and one of the most important sources of animal protein matters in the alimentation of rural populations of the tropical regions. For centuries, fishbreeding in ponds has been broadly practised in the Far East. Its application happened more recently in the African and American tropical regions, where, in fact, its true expansion goes back to only some fifteen years ago.

2. In the Far East, fishbreeding is practised in pools of brackish water, in ponds of soft water and in ricefields. Brackish water ponds or "tambaks" are particularly numerous in Indonesia and in the Philippines. Their main piscicultural production is that of the Chanos chanos (Milkfish), a fish that grows in the ponds, but the fry of which must be fished in the sea. The average yearly production of the "tambaks" is 225 kg per Ha. In soft water ponds, several species are reared together, the most important one being the common Carp, one form of which with scales and variable coloration is bred. Many other species are also bred. The pools are abundantly manured, especially with organic manure. In Indonesia, this practice permits a yearly average production nearing 200 kg per ha. The Carp is also the main fish for breeding in rice fields; other species are associated with it. According to methods, rice and fish are cultivated alternatively, or both are produced simultaneously. In Indonesia, the average production attains 140 kg per ha.

3. Fishbreeding has developed in many countries in Central Africa since 1946. It is mainly based on utilisation of the Tilapia. These fish reproduce very easily in captivity and accept rearing. They make very good use of vegetables (manioc, leaves, sweet potatoes, etc.), farinaceous matters and various sorts of refuse. T. macrochir and melanopleura were first utilised. Other species (T. nilotica, etc.) were then added; other fish for breeding are now being looked for in other families. Methods of fishbreeding are still being adjusted and one often meets difficulties in obtaining fishes of the same size. In this field one can practise breeding in two stages, or utilize other methods, such as interspecific crossbreeding, or the culture of Tilapia and of one predatory kind. Techniques of breeding still need improvement, but the human surrounding in which they are applied also needs to be improved.

4. In tropical regions, the breeding of fish in soft water ponds can take the character of family or local handicraft occupation or that of commercial or industrial enterprise. Fishbreeding of commercial or industrial character must be practised in pools of a rather large size. Intensification of production should be obtained either through organic or mineral nourishment, or through artificial nourishment. In order to pay, fishbreeding must be practised in economical circumstances, which is for instance possible if the breeding establishment is attached to an agricultural industry which supplies the fattening refuses. Fishbreeding of the family kind is practised in small sized pools. One should aim at intensifying their production, either through the organic manuring that is current practice in the Far East, or through daily artificial alimentation with vegetables and various forms of refuse. Such a practice is only possible if the pool is situated in the immediate vicinity of the fishbreeder's habitation. In this respect, important improvements could be realised in Africa. High production may also be obtained from the interbreeding of species with differing alimentary regimes, or from the mixing of classes of age, which is pretty broadly practised in the Far East and in Africa.

Finally, the depth of the breeding ponds should be sufficient but not exaggerated: one may consider that an average depth of one meter is satisfactory.

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**TIMBER-SEASONING PRACTICES UNDER CONDITIONS OF
HIGH HUMIDITY IN TROPICAL AREAS.**

by G.W. Wright, Division of Forest Products, Commonwealth
Scientific and Industrial Research Organization, Melbourne,
Australia.

1. The fundamentals of wood drying are not greatly influenced by climate, differences in timber species, drying processes, or geographic factors. However, seasoning practice is greatly concerned with such variants, because major considerations are the quality, speed, and economics of drying, often to the extent that procedures adequate for some areas are unsound for others. In tropical areas subject to high humidities most difficulties in seasoning are, in fact, posed by this climate, aggravated usually by frequent, heavy seasonal rains, and accentuated by insect and fungal attack. On the other hand, degrade due to excessively rapid drying can also occur in susceptible timbers, particularly round forms, during seasonal dry periods when temperatures remain high.

LOG PRE-TREATMENTS

2. The quality and recovery of sawn timber from logs in tropical areas are markedly affected by log storage conditions. Loss of quality can be caused by borer attack, splitting, and sapstaining which extends in some cases to decay. Pre-treatments are, therefore, often necessary especially during delay periods incidental to extraction after felling, or when prolonged storage is unavoidable.

3. These forms of degrade rarely reach serious proportions in round or sawn timber placed in pond storage quickly, or converted soon after felling and rapidly air- or kiln-dried. On the other hand, under warm humid conditions, sapstain or decay soon become serious in sapwood or susceptible heartwood stored in air while moisture contents remain above 30%, the extent and rate of attack depending on species, local climate, the particular conditions of exposure, and the rate of surface drying. Simultaneous insect attack is also common.

4. Protection from staining fungi, of which blue stain is the most important, can often be obtained by surface treatment with a suitable fungicide. Alternative methods of application are to de-bark and spray all surfaces, including ends with, say, either pentachlorophenol (2.0%) in a cheap mineral oil, or a water solution of sodium pentachlorophenate; or to retain bark and spray only the ends and those barrel surfaces from which the bark has been dislodged: in some respects the latter is possibly the better. For effective protection spraying must not be delayed beyond the day of felling.

5. Insect attack from pinhole borer (Ambrosia beetle) often occurs immediately after felling. Protection is generally based on a complete

spray treatment with benzene hexachloride (0.5% gamma isomer) or dieldrin (0.5%) in a mineral oil or as a water emulsion. It is often necessary to incorporate a fungicide and insecticide in the one spray.

6. Where there is a risk of end-cracking during dry periods, log ends should be given a coating of a heavy petroleum grease and wax mixture in which a fungicide has been incorporated. This must be given immediately after an end has been sawn and may be applied as a fairly thick coat by a paddle or brush.

THE SEASONING OF SAWN TIMBERS FOR JOINERY, FURNITURE AND GENERAL BUILDING PURPOSES

Selection of the Seasoning Process

7. In general, for the bulk of wood-using industries operating under humid tropical conditions, choice of seasoning process is at present limited almost entirely to either air drying, pre-drying or kiln seasoning, or a combination of these. Which should be chosen is determined primarily from consideration of size of operation, stock dimensions, drying behaviour, drying time and urgency of demand.

8. Where air-drying conditions are favourable, as is frequently the case in tropical areas, and assuming provision is made for protecting stock from rain, air drying has much to recommend it from considerations of drying economy and dried quality. Its main disadvantages are the investment required in both stock and yard facilities, the time required, its lack of flexibility for urgent drying tasks and, under tropical conditions, the comparatively high moisture content at equilibrium, particularly during wet monsoonal periods.

9. However, economy in drying is only one of a considerable number of factors for consideration, and in many circumstances accelerated methods, even at greater cost, are more attractive.

10. Pre-drying should be considered as a substitute for, or to supplement, partial air drying to moisture contents in the vicinity of fibre saturation point. It has particular value where protection from rain cannot be provided and repeated re-wetting seriously interferes with processing operations dependent on pre-seasoning, e.g. pressure preservation treatments.

11. Kiln seasoning has as its main advantage speed in drying to low moisture contents after a preliminary period of air drying or pre-drying, and is especially useful for custom drying purposes, where stock must be kept to a minimum, or where export or plant manufacturing operations are dependent on a continuity of supply and final high dried quality.

Air Seasoning

12. For reasons of simplicity and economy, air drying must remain the most widely practised method of seasoning for many humid tropical areas for the foreseeable future. Its efficiency will depend largely on the attention given to details of stacking and yard practice, as unsatisfactory methods simply defeat their purpose and result in uneven drying, sapstain and, ultimately, decay. These hazards are naturally greatest in sapwood and the sawn products of susceptible species such as Gonystylus spp. For these, pre-seasoning prophylactic treatments are usually necessary as a measure of control. Accordingly, where susceptible

material has not previously been protected by a general purpose diffusion or pressure preservation treatment, it should be dipped or sprayed in a combined fungicide, such as sodium pentachlorophenate (0.5 to 1.0%) and borax (1.5 to 3.0%), and an insecticide soon after conversion. Timber should not be exposed to heavy rain immediately after treatment. The protection provided is limited to a few months.

13. Stacking practice in humid tropical areas aims to accelerate drying rates and prevent, as far as possible, the development of zones of high humidity in and around the stacks. Recommended practices therefore comprise all measures likely to promote air circulation. These include: a sticker thickness not less than 1 in; a limitation of stack width to not more than 5 ft; adequate side spacing between individual stacks, e.g. spacing not less than 2 ft where more than two stacks are adjacent; stack-end spacings to form continuous air channels and not less than 6 ft wide; stack foundations of pier and bearer construction of a height not less than 18 in from ground level to lowest stack layer; a stack height not greater than 10 ft; and a yard site well exposed to prevailing winds, thoroughly drained, to ensure freedom from retained surface water following periods of rain, and kept completely free of weed growth or discarded timber.

14. Of major importance is the provision of covering to prevent the continued rewetting of drying stacks. This may take the form of one or more large open-sided sheds each capable of holding a considerable number of stacks; or a much greater number of smaller ones, each capable of taking only 2 to 4 stacks, and separated sideways and endways by alleys sufficiently wide to permit the movement of handling vehicles, e.g. side or end-loading fork trucks or mobile jib cranes.

15. Modern yard design tends to favour the smaller shed, as it ensures rapid and economic handling and maximum drying rate. With the large shed there is a grave risk of over-filling and restricting air movement unduly, thus accentuating the likelihood of delayed and uneven drying. Probably the greatest hazard with the small, isolated drying sheds is from driving rain: here the use of cane or bamboo blinds, or removable, light, slatted frames along the sides of the sheds is of considerable value.

Pre-driers and Pre-drying

16. Pre-driers are large, low-cost timber driers with forced-air circulation and, preferably, some form of heating - usually steam - to ensure accelerated drying conditions. They arose from the need for a substitute for partial air drying to moisture contents in the vicinity of fibre saturation point in cool temperate zones subject to adverse weather conditions and recently, they have been considered for use in moist tropical conditions, and the construction of a prototype for use in Bangkok, Thailand, has now been completed.

17. During the early stages of seasoning, i.e. above fibre saturation point, pre-driers are capable of accelerating drying to a rate equal to that obtainable from kilns. Their application appears to be suitable for the partial preliminary drying of sawn and round wood in all forms, including timbers for some engineering structures, and products of the less durable species requiring drying before and after preservative treatment, e.g. sleepers, bridge timbers, and poles and cross arms.

18. Some special advantages of pre-drying are: a reduction in drying time, at moisture contents above fibre saturation point, to some 10 to

20% of that required for air drying; convenience where land space is inadequate for air drying; continuity of output irrespective of weather conditions; flexibility in changing production schedules to meet urgent market demands; and avoidance of secondary problems from staining, insect attack, weather damage, and re-wetting.

19. It is emphasized that pre-driers cannot normally be justified economically where air drying conditions are predominantly good, i.e. in areas subject to protracted warm, dry conditions, and that in general they are less attractive than kilns for final drying to moisture-contents less than 20 to 25%.

KILN DRYING

20. A trend towards kiln drying is undoubtedly favoured by improving living standards and increasing industrialization, such as are evident in parts of south-east Asia, Africa, and Central and South America. However, for economic reasons some timber sizes are not usually kiln dried, even if facilities are available, except as a matter of urgency, e.g. thicknesses greater than 2 in. For the same reason, kiln drying from the green condition is mostly restricted to softwoods or thin hardwoods for case stock or special products.

21. The most technically and economically attractive seasoning practice for most hardwoods is a combination of partial air drying, or pre-drying to a moisture content in the vicinity of 20 to 25%, followed by kiln drying, and such final stress relief or other treatments as may be warranted, e.g. moisture conditioning or reconditioning. It also has advantages where large stock holding is impracticable, for custom drying, and when continuity of output is necessary at low moisture contents. However, in humid tropical areas certain special seasoning problems can develop. These are mainly due to the large volume of sapwood in trees of some tropical species, and the mixed-species nature of much tropical forest. In these cases segregation or aggregation for seasoning purposes may be necessary. For the large organization, segregation is desirable, so that each variable can be treated in the manner best suited to its needs without jeopardy to the uniformity of final moisture content or drying costs. For the small operation, complete segregation could lead to the slow rising of stacks, causing a risk of considerable moisture variation within stacks, and to surface checking in stack layers progressively exposed to the sun.

22. In these conditions aggregation is warranted, but caution is needed; in many cases not only should seasoning behaviour of the different timbers be similar, but also other characteristics, e.g. durability and behaviour under insect attack.

23. Careful attention to the packaging of kiln seasoned timber for export may be necessary. Some export markets specify low moisture content limits, requiring kiln drying to well below the local equilibrium moisture content. In this event subdivision of the order into unit packages immediately after seasoning and wrapping with a water and vapour-proof sheet e.g. polythene, would seem a satisfactory procedure.

KILN DESIGN AND CONSTRUCTION

24. When tropical forest contains many different species this often leads to the conversion of a wide range of timbers, in which circumstances the smaller compartment type kiln, providing a choice of sizes extending from, say, 500 to 1000 cu ft per charge, undoubtedly has advantages over

the larger compartment or the progressive unit, particularly where plant throughput is comparatively small.

25. Kiln design and construction for humid tropical areas involves no radical changes from that for more temperate zones. However, some economies in kiln construction may be made, as heat insulation is not so critical, and some redesign of venting, to allow for the high humidity of the external air, may be necessary.

26. For kiln charging and discharging, the choice lies between the use of kiln trucks, the Christensen-type lifting truck, and straddle or fork-lift trucks. From considerations of reliability, simplicity and economy, the Christensen system is recommended, with yard-handling to the kiln site being carried out by any of a Christensen truck, a fork lift truck, a straddle truck, a mobile crane, or an overhead travelling crane, whichever is most convenient.

ECONOMIC FACTORS

27. In favourable climates air drying to moisture contents of the order of 25% is invariably cheaper than pre-drying or kiln drying, in both capital investment and drying cost.

28. On the other hand, where climatic conditions are adverse for an appreciable part of the year and air drying is prolonged, it usually means a large expenditure in drying stock and yard facilities to hold and service this stock, i.e. access roadways, handling equipment, stack supports, stack covering, yard drainage, fencing, fire protection and the like. In this case capital expenditure for air drying can exceed that for pre-drying. However, pre-drying direct costs will usually remain higher because of the heating, and to a lesser extent, the power charges involved.

29. Pre-drying is usually much cheaper than kiln drying from considerations of both capital investment and drying cost where the drying of tropical hardwoods needs to be accelerated at moisture contents above the fibre saturation point.

30. Kiln drying is, therefore, the most costly of all three methods of seasoning, but for a number of reasons is generally the most attractive for drying to low values from moisture contents below the fibre saturation point. The question of choice between combined partial air drying and kiln drying, or combined pre-drying and kiln drying is, in some cases, dependent on the extent to which stack covering is provided, and facilities for rapid processing for, say, custom drying, are necessary to ensure patronage, even if this is at the expense of greater drying cost.

31. For pre-drying and kiln drying the major items of cost are overhead and heating charges; fuel cost contributes to the latter very considerably. Important measures for economic operation are, therefore, low-cost building construction and a cheap fuel; one of the cheapest is wood waste, e.g. sawdust, planer shavings and sawmill offcuts.

SEASONING OF ROUND AND LARGE SAWN TIMBERS

32. Time and economic considerations rarely favour the seasoning of round or large sawn timbers of naturally durable species for general construction purposes, e.g. poles, posts, cross arms, sleepers, or dwarf or bridge timbers. However, the development of the wood pre-

servation industry has enabled the successful utilization of sapwood and timber species not naturally durable for many purposes where an extended service life is required, even under the conditions of high decay and insect hazard commonly encountered in humid tropical regions.

33. In many cases the required protection is best obtained by a pressure process for which some pre-seasoning is necessary, usually to a moisture content approximating 30% in those zones in the wood which require treatment. Pre-seasoning, or post-seasoning may be obtained by air drying, or an accelerated process such as pre-drying, boultonizing, steam-and-vacuum drying, or vapour drying.

34. The selection of the seasoning process depends as for other timbers on the conditions in the timber yard and the financial considerations involved. Where an accelerated method is favoured, pre-drying is probably the most flexible and the simplest to control. On the other hand, boultonizing, steam-and-vacuum drying and vapour drying, while somewhat less versatile, give very much faster drying times and more rapid throughput.



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Australia

TIMBER-SEASONING PRACTICES
UNDER CONDITIONS OF HIGH HUMIDITY
IN TROPICAL AREAS

By G.W. WRIGHT,
Division of Forest Products,
Commonwealth Scientific
and Industrial Research Organization,
Melbourne, Australia

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**TIMBER-SEASONING PRACTICES UNDER CONDITIONS OF
HIGH HUMIDITY IN TROPICAL AREAS.**

by G.W. Wright, Division of Forest Products, Commonwealth
Scientific and Industrial Research Organization, Melbourne,
Australia.

Most problems of timber seasoning in humid tropical climates arise from the inherent high humidity itself, lack of protection from frequent heavy rains and the damp conditions engendered by them, insufficient air movement through drying stacks, and an accentuated fungal and insect attack encouraged by these conditions.

Unsatisfactory log harvesting and storage methods can initiate down-grading, particularly from sapstain and borer damage, from decay (a longer term problem), and in some circumstances from log splitting during seasonal dry periods.

The most effective solution is the rapid extraction and conversion of logs, if possible within 24 hours, followed by immediate seasoning.

Where this is impracticable, prophylactic measures are necessary. These are provided by a dip or spray using a fungicide to control stain, e.g. a chlorinated phenol, and an insecticide to control insect attack, e.g. dieldrin or benzene hexachloride. For end protection against splitting, a heavy coating of a petroleum grease, preferably containing a fungicide, is effective.

Seasoning in humid tropical areas can be by air drying, pre-drying or kiln drying, or a combination of these.

Air drying, although slow, has the widest application because of its simplicity and economy. Its main disadvantages are the comparatively high capital investment in stock and yard facilities, the time required, and its inability to provide low moisture contents when the prevailing equilibrium moisture content is high.

The efficiency of air seasoning depends on the effectiveness of pre-seasoning prophylactic measures, and on stacking practice and yard layout which must aim at maximum air movement to prevent the development of zones of highly humidified air in or around stacks. For stack covering a number of small sheds is often preferable to a large shed in which air movement may be inhibited.

Pre-driers are used mostly for preliminary partial drying mainly in tropical regions subject to heavy seasonal rains, high humidities and little wind, particularly where repeated re-wetting would interfere with the operation of dependent processes, e.g. pressure preservation treatments

Other advantages of pre-drying are: a reduction to about 10 or 20%

of the time required for air drying; considerable reduction in stock holding and land space; continuity of output irrespective of weather; flexibility for rapid changes in production schedule; and avoidance of sapstain, insect attack and weather damage.

There is a trend towards kiln drying in many humid tropical areas because it provides a continuity of well seasoned stock, a means of quality control for export or manufacturing purposes, and a minimum of stock holding. However, in these areas special kiln-drying problems can develop due to the large volume of sapwood in trees of some species, and the mixed-species nature of some forests. Then questions of segregation and aggregation for seasoning arise.

The small compartment kiln often has advantages over the large compartment or progressive types because of its value where stock has to be segregated into small parcels to suit differences in drying behaviour.

No radical changes are generally necessary in the design of kilns suitable for other areas. However, economies in building construction may be made because heat insulation is not so critical. Some redesign of venting may be necessary.

Air drying of hardwoods to moisture contents approximating 20 to 25% though cheap in terms of capital investment and drying cost can be dearer in capital expenditure on plant and stock than pre-drying. The costs of pre-drying are in overhead charges on installation cost, and in heating. However, for drying from the green condition to about fibre saturation point, pre-drying plant and drying costs are usually only about one-quarter to one-third of those for kilns. Kiln drying is the most costly of all three methods for drying hardwoods from the green condition, but is generally economical for timbers up to 2 in thick at moisture contents below 25% after partial air-drying or pre-drying.

Pre-seasoning to 30% moisture content is usually necessary for satisfactory pressure preservation treatments of sapwood, or of timbers of non-durable species.

Air seasoning is generally satisfactory for small yards where air-drying conditions are favourable, but for larger operations where there is need for rapid drying, or continuity in production under poor weather conditions, accelerated methods are better. Of these, pre-drying is probably the most flexible, but where maximum drying rates and rapid plant throughput are necessary, specialized methods such as boultonizing, vapour drying, and steam-and-vacuum drying have advantages.

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USE OF RADIATION AND CHEMICAL MUTAGENS IN THE PRODUCTION OF MUTATIONS
IN A CROP OF RELEVANT INTEREST TO MEDITERRANEAN AGRICULTURE, DURUM WHEAT.

By G.T. SCARASCIA MUGNOZZA, S. AVANZI, M.L. BELLI, A. BOZZINI, T. CERVIGNI,
L.M. MONTI, G. MOSCONI, Laboratorio per le Applicazioni in Agricoltura,
C.N.E.N.,

and F. D'AMATO, G. MARTINI, Institute of Genetics, Pisa University

1. INTRODUCTION

Durum wheat, the raw material for macaroni production, is essentially a crop of semi-arid climates; it is grown mostly in Southern Europe, North America, North Africa, Near East, URSS and Argentina. Yield of durum is substantially less than that of bread wheat. Production of durum wheat in the Mediterranean countries, for which data are available, (Table 1), covers nearly 80 per cent of world production. In Italy, which is the largest producer in Western Europe, durum yields have declined every year from 1957 to 1960, whereas acreage was virtually unchanged.

In view of the economic importance of durum wheat in Italy, and in the Mediterranean area generally, a program on experimental mutagenesis in this crop started in 1956, for both fundamental genetic research and breeding of improved lines. So far, mutation induction by seed treatment has been carried out in the varieties Cappelli, Aziziah, Russello, Grifoni and Garigliano; the mutagens used were X-rays, thermal neutrons, fast neutrons, ethyl methane sulphonate (EMS) and diethyl sulphate (DS). The total number of treated seeds amounted to 65,000. Among the five varieties employed in our experiments, Cappelli covers more than 50 per cent of the acreage of durum wheat in Italy, owing to flour quality and relatively good yield. Therefore, our efforts have been concentrated on this variety.

2. TYPES OF INDUCED MUTATIONS

a) Chlorophyll mutations.

Scoring of chlorophyll mutations in the M_2 generation (progeny of plants grown from treated seeds) took place in the greenhouse; a total number of 20,200 spikes, belonging to 5,902 M_1 plants, were analyzed. The following types of mutations were found: albina (white), xantha (yellow), xanthalba (leaf tip yellow, base white), chloroalbina (tip yellow-greenish, base white), viridoalbina (tip light green, base white), striata (white or yellow longitudinal stripes), tigrina (brown or yellow transverse stripes), chlorina (yellow green), viridis (light green). The relative frequencies of the various types of chlorophyll mutations

(mutation spectra) induced by EMS and DS are significantly different from those induced by radiations. Within the three types of radiations used, differences in mutation spectra are not significant or are at the limit of significance.

Figure I shows the frequencies of chlorophyll mutations per spike progeny induced in durum wheat by the different mutagenic treatments applied. As shown by figure I, the mutation frequencies rise up to more than 6% in some neutron irradiations; this maximum value is comparable to, and possibly higher than, that found in radiation experiments in another tetraploid wheat species, Triticum dicoccum (1,2). If the M_2 mutation frequencies are considered in relation to M_1 survival, it is observed that, at comparable survival rates, the mutation frequencies induced by thermal and fast neutrons are several times higher than those produced by X-rays (3). This result is in agreement with the well known greater biological efficiency of neutrons as compared to X-rays.

A characteristic common to the three types of ionizing radiations used is that high mutation rates are induced by doses producing a strong reduction, generally from 50 to 80%, in the mean number of M_2 seedlings per spike (in practice, average spike fertility). On the contrary, with EMS and DS, the highest mutation frequencies are observed in treatments producing only a 33 to 42% reduction in the mean number of M_2 seedlings per spike (3). This contrasting behaviour of radiations on one side and chemicals on the other is clearly shown in figure II, illustrating, for each of the five mutagens used, the frequency distribution of chlorophyll mutations in mutated spikes, grouped in classes according to the number of seedlings produced by each of them (values relative to the average of controls taken = 100). It is apparent that, with chemical mutagens, spikes carrying mutations accumulate towards higher classes, while the opposite holds true for ionizing radiations. More precisely, in chemically treated material, the highest relative percentages of mutated spikes are found in the classes from 60-80 to 100-120; with radiations, a similar situation occurs in the classes from 20-40 to 60-80.

Another conspicuous difference in action between radiations and chemical mutagens lies in the size of mutated sectors in M_1 spikes as revealed by M_2 segregation ratios. Taking into account all radiation experiments, the mean segregation ratio was 15.9% (range 11.6-19.7%). In contrast to radiations, the segregation ratios found in chemically treated material ranged from 3.9 to 14.9% (mean 11.8%). This situation seems to be best explained by a more severe elimination of cells in the spike primordia of seeds following irradiation. In spite of the clear reduction in size of mutated sectors in M_1 spikes from chemically treated seeds, a comparable average number of mutants per mutated spike is observed with both chemical mutagens and radiations. This result, to be ascribed to the compensating effect of the better M_1 spike fertility in chemical mutagen treatments, may be of significance for the plant breeder also (3).

b) Viable mutations.

In M_2 and following generations in durum wheat, viable mutations affecting several physiological and prominent phenotypic characters have been isolated. At present, a total of 268 mutations, each of which derived from a single M_1 plant, is available at our Laboratory. These mutations involve either single or several characters (complex phenotypes) manifesting themselves in the various stages of the vegetative cycle (Table 2). Among the mutations listed, two appear to be of evolutionary interest, namely:

- i) "vavilovoid", characterized by an increased number of nodes and strong elongation of the internodes in the rachilla, leading to a pseudo-branched spike. This character, resembling the naturally occurring pseudo-branched spike of the hexaploid Triticum vavilovii Jakub., behaves as a simple recessive;
- ii) "supernumerary spikelets", showing 3 to 7 spikelets on each rachis node instead of one, as normally in Triticum. Also this character behaves as a simple recessive.

The whole of the mutations available is at present being made the object of genetic and cytogenetic studies. Since a large portion of the induced mutations in durum wheat are phenotypically similar to the naturally occurring ones, special attention is deserved to the inheritance of the induced changes. 12 different types of viable mutations analyzed so far have all shown a monogenic type of inheritance (recessive).

Analysis at meiosis of mutants and of their F_1 crosses to the mother line has demonstrated the occurrence, in 25 out of 50 mutants studied, of reciprocal translocations. This indicates that, in durum wheat, induced mutations often occur in association with chromosome structural changes. It is expected that reciprocal translocations, of so common an occurrence in durum wheat, might greatly help in the analysis of the genetic structure of this species.

3. AGRONOMIC EVALUATION OF THE MUTANT LINES

Considering the requirements for the improvement of Italian varieties of durum wheat, several induced mutations (short straw, solid stem, higher lodging resistance, increased spike and spikelet fertility) seem to be very promising.

Large-scale field trials for an agronomic evaluation of some of the induced mutants have been greatly facilitated by the establishment, in 1960, of a Research group on durum wheat, sponsored by the Italian National Research Council. The Research group includes, besides our Laboratory, the following Institutes: Institute of Genetics of the University, Pisa (Director: Prof. F. D'Amato), Institute of Cereal Genetics of the Ministry of Agriculture (Director: Prof. U. De Cillis), Institute of Plant Pathology of the University, Bari (Director: Prof. A. Ciccarone), Institute of Agronomy of the University, Bari (Director: Prof. L. Cavazza) and Institute of Agronomy of the University, Sassari (Director: Prof. R. Barbieri).

In the seasons 1960-1961 and 1961-1962, field trials have been carried out in 4 Stations in Southern and Central Italy and in Sardinia, namely: Bari, Foggia, Roma and Cagliari. Data on the performance of some of the mutants in the four localities are shown in Figure III. It is seen that the mutant lines M26, M34, M38, M62 manifested a good performance in most trials, reaching in some of them yields significantly higher than those of the mother line "Cappelli" (* $P = 0,05$; ** $P = 0,01$). A similar behaviour has been demonstrated in the lines M124 and M177, so far tested at Rome and Bari only.

A good yielding ability was observed also in other mutants, often associated with good quality (yellow berries absent), increased 1000-kernel weight, short straw and increased lodging resistance. The phytopathological analysis of mutants of agronomic interest has given an indication of the induction of resistance to mildew and Septoria in some of them.

"Cappelli", a variety with a satisfactory lodging resistance, becomes very lodging sensitive in fertile soils and, particularly so, in consequence of nitrogen manuring. To verify if some mutants had a higher lodging resistance in soils with high nitrogen content, an experiment with 8 short straw mutants was carried out. The behaviour of the control and of 3 of those mutants at different nitrogen levels is shown in Fig. IV. It is apparent that some mutants can use nitrogen fertilization better than the control (see M115 and M107), probably because of their higher lodging resistance.

In spite of the favourable prospects on the direct utilization of induced mutations, crosses aiming at the transfer into single lines of some of the best characteristics obtained by mutation are being carried out.

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TABLE 1

DURUM WHEAT AREA, PRODUCTION AND YIELD (AVERAGE 1957-1961) IN SOME MEDITERRANEAN COUNTRIES
(Data from FAO CCP/Grains/62/12, 14 June 1962).

	AREA (Thousand Hectares)	PRODUCTION (Thousand Metric Tons)	YIELD (Quintals per Hectare)
ITALY	1384	1527	11,0
SPAIN	450	415	9,2
PORTUGAL	180	124	6,9
FRANCE	50	60	12,0
ALGERIA	1347	906	6,7
TUNISIA	1091	350	3,2
MOROCCO	1016	682	6,7
TURKEY	1700	1663	9,6
SYRIA	1448	769	5,3
IRAQ	785	385	5,0
TOTAL	9451	6891	7,3

Table 2. - Types and number of viable mutations for individual and complex characters in durum wheat induced by radiations and chemicals.

MUTATIONS	X	N	C(★)	Total
Tigrina	2	21	11	34
Viridis	-	17	5	22
Chlorina	2	10	7	19
Virescens	3	13	8	24
Dark green	1	-	-	1
Prostrate tillering	1	2	-	3
Short leaf	1	-	-	1
Anthocyanic leaf	2	14	6	22
Narrow leaf	-	1	-	1
Solid stem	1	-	-	1
Solid stem, lax ear	1	-	-	1
Waxless	4	8	-	12
Waxless (spike only)	-	-	1	1
Short straw	-	31	-	31
Compact ear	1	4	-	5
Squarehead	-	1	-	1
Tetragonal ear	2	-	-	2
Lax ear	-	11	-	11
Red brown spotted awn and glume	1	4	1	6
Awned glume	1	-	-	1
Falcate caryopsis	-	1	-	1
Shrunken endosperm	1	-	-	1
Dwarf, late	-	2	1	3
Dwarf, twisted culm and leaf	1	1	-	2
Vavilovoid	2	5	1	8
Brachytic, compact ear	1	3	-	4
Brachytic, twisted ear	1	2	-	3
Supernumerary spikelets	-	1	1	2
Short straw,narrow leaf,slender ear,awned glume	4	5	-	9
Short straw,plicate leaf,awned glume	-	1	-	1
Short straw,short leaf,compact ear	1	-	-	1
Short straw, lax ear, attenuated glume	-	3	-	3
Short straw, narrow leaf, slender culm	-	2	-	2
Short straw, narrow leaf, compact ear	-	1	-	1
Short straw, compact ear	-	1	-	1
Short straw, narrow leaf, lax ear	-	1	-	1
Short straw, lax ear, awned glume	-	8	-	8
Short straw, compact ear, awned glume	1	5	-	6
Short straw, lax ear	-	4	-	4
Short straw, awned glume	-	3	-	3
Short straw,compact ear,attenuated caryopsis	-	1	-	1
Tall, small glume and caryopsis	-	1	-	1
Small ear and caryopsis	-	1	-	1
Narrow leaf, short glume, small caryopsis	-	1	-	1
Compact ear, awned glume	-	1	-	1
Total mutations	35	191	42	268

(★). X = X rays; N = Neutrons; C = Chemicals

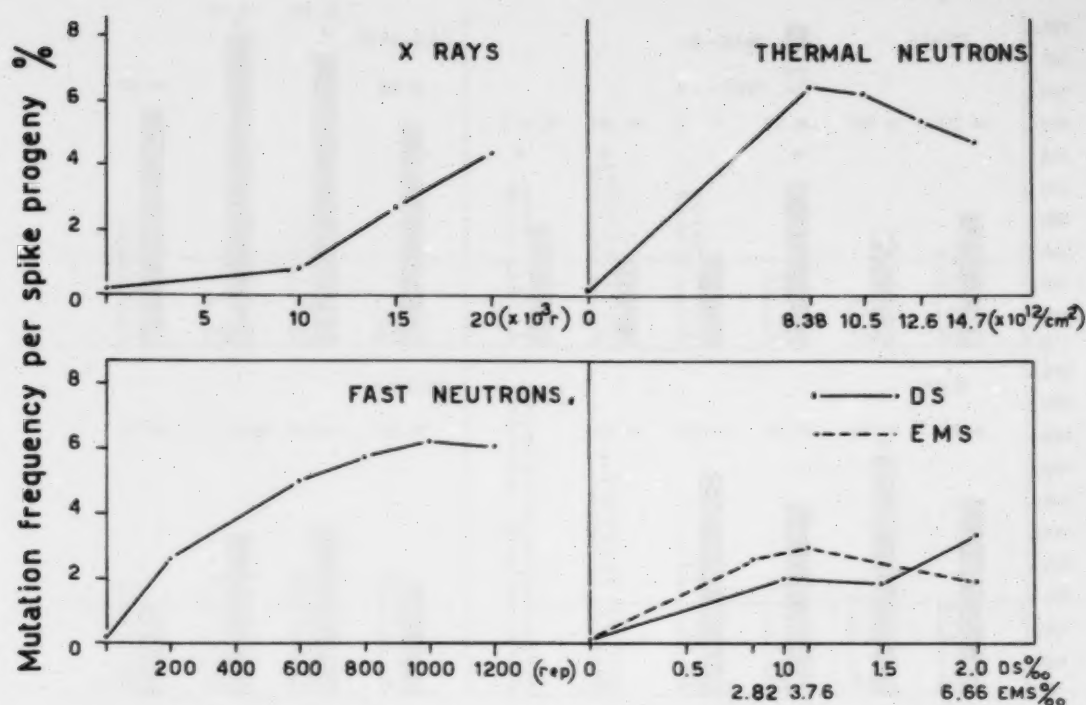


Fig. I - Frequency of chlorophyll mutations induced in durum wheat by X rays, thermal neutrons, fast neutrons, diethylsulfate (DS), and ethylmethanesulfonate (EMS).

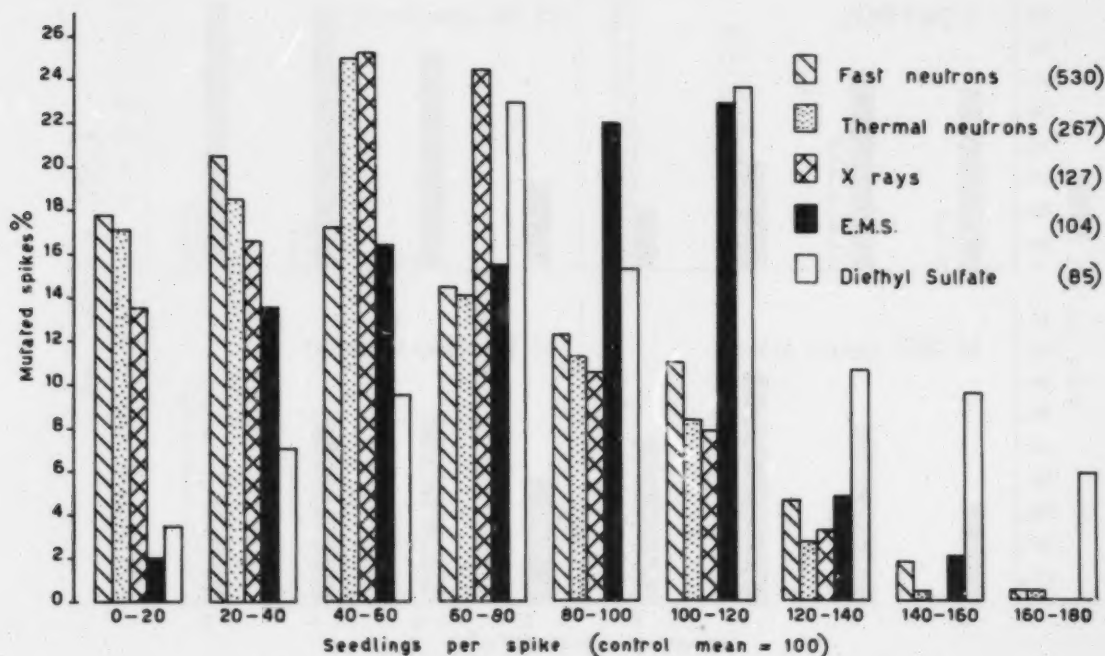


Fig. II - Frequency distribution of mutated spikes grouped according to number of seedlings per spike (in brackets total no. of mutated spikes observed).

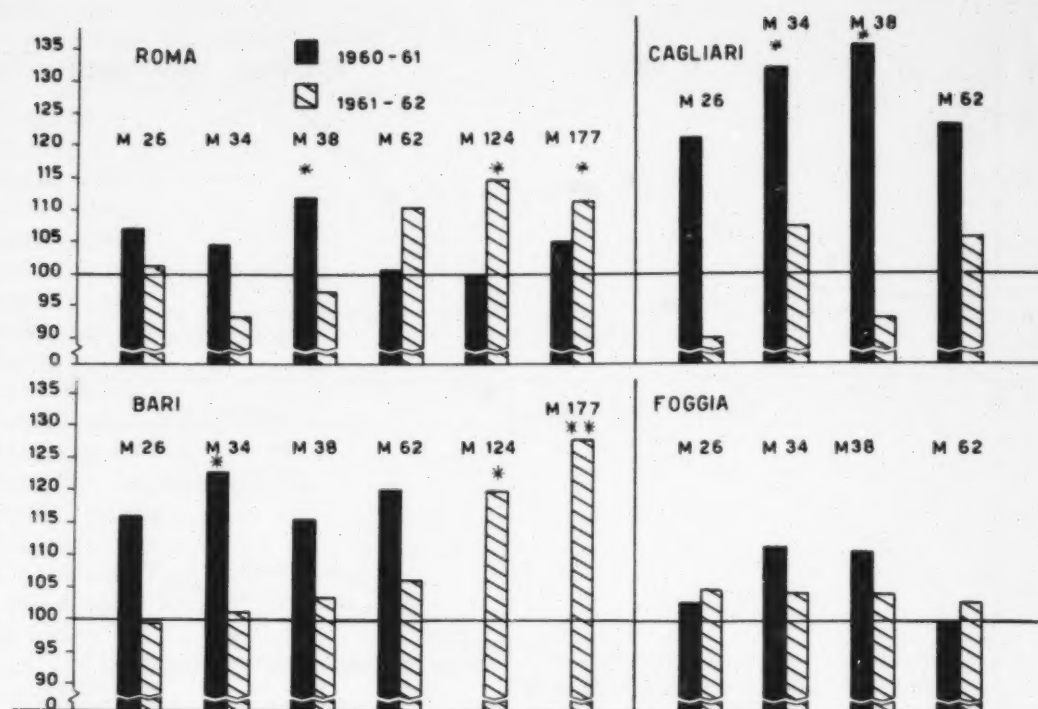


Fig. III - Yield of durum wheat mutants (in % of control) in different trials.

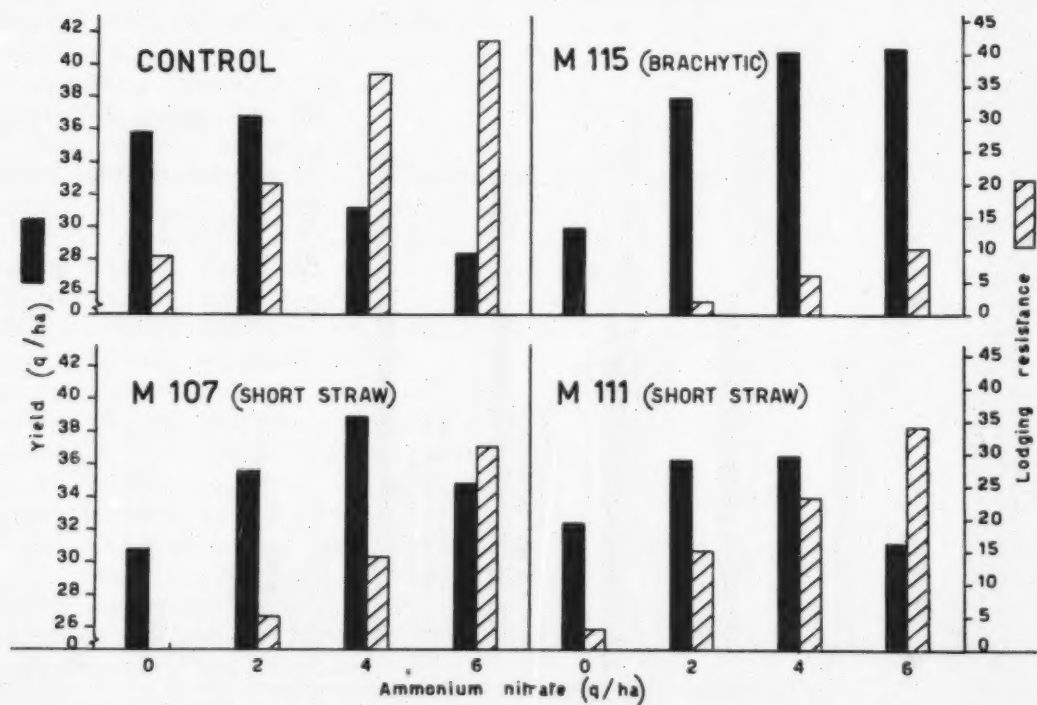


Fig. IV - Yield and lodging resistance in 3 durum wheat mutants grown at different nitrogen levels (0=no lodging; 45=maximum lodging).

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C.4.1.

USE OF RADIATION AND CHEMICAL MUTAGENS IN THE PRODUCTION
OF MUTATIONS IN A CROP OF RELEVANT INTEREST TO MEDITERRANEAN
AGRICULTURE, DURUM WHEAT.

by G.T.Scarascia Mugnozza, Laboratorio per le Applicazioni in
Agricoltura, C.N.E.N.

S. Avanzi,	"	"	"	"	"
M.L. Belli,	"	"	"	"	"
A. Bozzini,	"	"	"	"	"
T. Cervigni,	"	"	"	"	"
L.M. Monti,	"	"	"	"	"
C. Mosconi,	"	"	"	"	"
F. D'Amato, Institute of Genetics, Pisa University.					
G. Martini,	"	"	"	"	"

SUMMARY

Durum wheat, the raw material for macaroni production, is essentially a crop of semi-arid climates; it is grown mostly in Southern Europe, North America, North Africa, Near East, URSS and Argentina. Yield of durum is substantially less than that of bread wheat. Production of durum wheat in the Mediterranean countries, for which data are available (Table 1), covers nearly 80 per cent of world production. In view of the economic importance of durum wheat in Italy, and in the Mediterranean area generally, a program on experimental mutagenesis in this crop was started in 1956, for both fundamental genetic research and breeding of improved lines. So far, mutation induction by seed treatment has been carried out in the varieties Cappelli, Aziziah, Russello, Griffoni and Garigliano; the mutagens used were X-rays, thermal neutrons, fast neutrons, ethyl methane sulphonate (EMS) and diethyl sulphate (DS).

Scoring of chlorophyll mutations in the M_2 generation (progeny of plants grown from treated seeds) took place in the greenhouse; a total number of 20.200 spikes, belonging to 5,902 M_2 plants, were analyzed. The following types of mutations were found: albina, xantha, xanthalba, chloroalbina, viridoalbina, striata, tigrina, chlorina, viridis. The relative frequencies of the various types of chlorophyll mutations induced by EMS and DS are significantly different from those induced by radiations. Within the three types of radiations used, differences in mutation

spectra are not significant or are at the limit of significance. Figure I shows the frequencies of chlorophyll mutations per spike progeny induced in durum wheat by the different mutagenic treatments applied. A characteristic common to the three types of ionizing radiations used is that high mutation rates are induced by doses producing a strong reduction, generally from 50 to 80%, in the mean number of M_2 seedlings per spike (in practice, average spike fertility). On the contrary, with EMS and DS, the highest mutation frequencies are observed in treatments producing only a 33 to 42% reduction in the mean number of M_2 seedlings per spike. This contrasting behaviour of radiations on one side and chemicals on the other is clearly shown in figure II. Another conspicuous difference in action between radiations and chemical mutagens lies in the size of mutated sectors in M_1 spikes, as revealed by M_2 segregation ratios. Taking into account all radiation experiments, the mean segregation ratio was 15.9% (range 11.6-19.7%). In contrast to radiations, the segregation ratios found in chemically treated material ranged from 3.9 to 14.9% (mean 11.8%).

In M_2 and following generations in durum wheat, viable mutations affecting several physiological and prominent phenotypic characters have been isolated. At present, a total of 268 mutations, each of which derived from a single M_1 plant, is available at our Laboratory. These mutations involve either single or several characters (complex phenotypes) manifesting themselves in the various stages of the vegetative cycle (Table 2). The whole of the mutations available is at present being made the object of genetic and cytogenetic studies. Since a large portion of the induced mutations in durum wheat are phenotypically similar to the naturally occurring ones, special attention is deserved to the inheritance of the induced changes. 12 different types of viable mutations analyzed so far have all shown a monogenic type of inheritance (recessive). Analysis at meiosis of mutants and of their F_1 crosses to the mother line has demonstrated the occurrence, in 25 out of 50 mutants studied, of reciprocal translocations.

Considering the requirements for the improvement of Italian varieties of durum wheat, several induced mutations (short straw, solid stem, lodging resistance, increased spike and spikelet fertility) seem to be very promising. In order to evaluate their agronomic properties, some of them have been included in field trials carried out also by Profs: U. De Cillis, Institute of Cereal Genetics, Rome; A. Ciccarone, Institute of Plant Pathology, Bari; L. Cavazza, Institute of Agronomy, Bari and R. Barbieri, Institute of Agronomy, Sassari, on behalf of the Italian National Research Council. These experiments have been going on since 1960 in 4 Stations in South and Central Italy and Sardinia, namely: Bari, Foggia, Roma and Cagliari. Data on the performance of some of the mutants are shown in Figure III. To verify if some mutants obtained had a higher lodging resistance in high nitrogen soil content, an experiment with 8 short straw mutants was carried out. The behaviour of the control and of 3 of those mutants at different levels of nitrogen is shown in Fig. IV.



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THE ROLE OF FARM MANAGEMENT
IN RELATION TO THE TECHNOLOGICAL DEVELOPMENT
OF THE AGRICULTURAL INDUSTRY

By J.C. GILSON,
Department of Agricultural Economics,
University of Manitoba

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THE ROLE OF FARM MANAGEMENT IN RELATION
TO THE TECHNOLOGICAL DEVELOPMENT OF
THE AGRICULTURAL INDUSTRY

by J. C. Gilson

Department of Agricultural Economics
University of Manitoba
Winnipeg, Canada

(1) It was observed by Polanyi in his book, The Great Transformation that, "at the heart of the Industrial Revolution in the 18th century there was an almost miraculous improvement in the tools of production, which was accompanied by a catastrophic dislocation of the lives of the common people." ^{1/} The technological revolution in Canadian agriculture of the 20th century, while perhaps not as dramatic in its dimensions as the industrial revolution, has had profound and far-reaching implications for the individual farmer and his rural community.

(2) More changes have occurred in Canadian agriculture during the past two decades than during the previous half-century. In some ways it appears that the rate of technological progress has occurred faster than the agricultural industry as a whole has been able to absorb. It has called for economic and social adjustments for which many farmers in Canada have not been adequately prepared. Technological advance has created a complex, highly capitalized business unit for which many farmers have neither the managerial skill or finances to cope. It has transferred most of the services previously produced on the farm to the rapidly growing agri-business sector of the economy, and in the process has exposed farmers to new problems of processing, marketing and bargaining power. Technological developments in agriculture have resulted in drastic changes in the farmer's rural institutions and his community, changes which he neither understands completely or accepts.

(3) There is no intention here to deplore the technological developments which have occurred in Canadian agriculture. A progressive nation depends on the abundance and efficiency of its food producing industry. Indeed, a large part of the economic development of the Canadian nation may be traced to the technological developments which have taken place in the agricultural sector of the economy. What we do intend to examine in this paper is the proposition that there is a growing gap between the technological possibilities of the agricultural industry and the corresponding economic adjustments needed at the individual farm level.

I

(4) Before we attempt to evaluate the impact of technological advances on the individual farm business, it is necessary to examine briefly the nature of these advances during the past quarter century. Gregor Mendel's pioneering work on the "Laws of Inheritance" were rediscovered in 1901. But it was not until the last two decades that the full force of the science of genetics was to be felt in the fields

^{1/} Polanyi, K., The Great Transformation, p. 33, New York, (1944)

of plant and animal breeding. While the potential of the gasoline engine for agricultural uses was demonstrated during the 1920's, it was not until the last World War that tractors and self-propelled grain harvesters were widely used in Canada. Chemical control of weeds and insects was first attempted during the 1930's but it was not until the last decade that Canadian farmers really began to take full advantage of chemistry in their farming practices. Antibiotics and hormones have led to dramatic developments in the field of animal and poultry nutrition. Rural electrification has done more than any other innovation to reduce hand labor in farming and to permit an increasing degree of automation in the industry.

(5) There has been an implacable output of new discoveries from our agricultural research laboratories during the past quarter century, and the technological revolution is continuing. Even now plant scientists, through the process of chromosome substitution, are producing entirely new and higher yielding plants. The field of chemical genetics and the exciting new discoveries being made with respect to desoxyribonucleic acid (DNA) in the nucleus of the living cell could generate still another scientific revolution in the field of agricultural production. The research work connected with the use of radioactive tracer techniques in plant and soils research, and in animal breeding and nutrition, promises new technological breakthroughs in agricultural production. New uses of chemistry in farming are still to be discovered. One can only guess what further advances will be made in terms of automating and mechanizing production processes in agriculture. We do know, for example, that mechanization has reduced the hand labor requirements in sugar beet production from 70 hours to 10 hours per acre, and in dairy production from 200 hours annually per cow to less than 75 hours over the last 20 years. We have seen the tractor and the self-propelled grain harvester replace a great number of horses and hired men from agriculture since 1940.

(6) It appears that technological innovations will continue to be injected into the Canadian agricultural industry regardless of the economic consequences for the individual farmer. This will be the inevitable result of the publicly sponsored type of agricultural research and extension services in Canada. It will be aided and abetted by the dominant philosophy that the goal of research and technological progress should be one of making two blades of grass grow where one grew before, or of making it possible for one man to do what two men did previously. ^{2/} There can be little doubt of the validity of such a philosophy. Unfortunately, however, we have not made the same progress in terms of dealing with the implications of technological progress for the individual farm business.

II

(7) Between 1941 and 1959 the farm labor force in Canada declined from 1.1 million to 692,000 persons. But underemployment is still a major problem in many parts of Canadian agriculture. During the same period of time the number of farms in Canada declined from 677,500 to less than 500,000 and still the "small farm problem" persists in many regions of the country. Many farms in Canada are badly undercapitalized even though capital investment for the industry as a whole increased from 4.2 billion to over 10 billion dollars over the past two decades. Farmers in Western Canada increased their fertilizer expenditures 3 times since 1941 and yet it is estimated that half the farmers have still not used fertilizer to date. Technological advances have called for a change in farming from a way of life to a business and still there are

^{2/} Heady, E.O., "Basic Economic and Welfare Aspects of Farm Technological Advance", Journal of Farm Economics, May (1949) Heady divides technological innovations as they apply to agriculture into two broad classes: the biological innovation which represents an output-increasing type of technology such as chemical weed sprays, hybrid cereals and insecticides; and the mechanical innovation which represents a labor saving type of technology such as tractors and rural electrification.

thousands of farmers in Canada who are presently classed as semi self-subsistence. A large number of Canadian farmers are still better qualified as workers than managers, even though the rewards are going increasingly to the well-managed farms. Technologically displaced farm people have been squeezed out of agriculture into other occupations for which they were ill-trained. Technological progress has reached out into the rural institutions with seriously disturbing effects. The school, the church, the village and the rural neighborhood have all been drastically changed within the last two decades.

(8) The above is not to suggest that Canadian agriculture is badly maladjusted or unresponsive to change. Changes and adjustments have taken place. Very substantial technological progress has been made. The point that is being made here is that the problems in Canadian agriculture are becoming less technological and more economic and social in nature. There is a large and growing gap between what is technologically possible and what is needed by way of economic adjustment if technology is to become the full blessing which it is intended to be.

(9) If the economic and social consequences of rapid technological progress in agriculture are disturbing for the advanced countries with a rapidly developing industrial economy, such progress could have serious and unpredictable results in countries whose economies are primarily agricultural, and whose culture and social traditions are even more opposed to rapid change. The advanced countries have a greater capacity to absorb the results of a rapid technological progress in agriculture. For example, technologically displaced persons from agriculture in the advanced industrial economies have the opportunity - albeit a limited one for many - to seek employment in non-farm industries. It is doubtful, however, if the same capacity for change exists at the present time in the economies of the less advanced countries of the world. ^{3/} As imperative as the need might be for an efficient agricultural industry in such countries, it would appear unwise to permit an indiscriminate or too rapid a development of technological innovations in the farming industry. One writer made the following comment with respect to less advanced economies. ^{4/}

"Any widespread use of mechanical power would present both economic and social problems. - - - The point here emphasized for Mexico and many other similar countries is that improvement, which is much to be desired, does not necessitate supplanting crude tools with tractors. Mechanization may proceed in shorter steps from sickle to scythe, for example, a step which many Mexican farmers have not yet made."

III

(10) Before we examine the problems of adjustment and resource use at the individual farm level, we should recognize the institutional nature of the primary production unit in Canadian agriculture. The single proprietorship is the predominant type of firm in Canadian agriculture at the present time. Ownership and management control, as well as the labor required for the business, are generally identified with one person or family. This is the main prerequisite of the so-called family farm in Canada. It is the firm conviction of farm people in Canada that any forces or changes which separate the tri-part functions of owner-operator-manager from the farmer and his family result accordingly in a weakening of the family farm. ^{5/}

^{3/} It should be noted, however, that even in a so-called advanced industrial economy such as Canada we have regions in the less developed sectors of the agricultural industry in which there exists chronic and persistent poverty. Culture, tradition, low education, fear of the unknown and ignorance of alternative opportunities make change in these areas extremely slow and difficult.

^{4/} De Graff, Harrold, "Some Problems Involved in Transferring Technology to Underdeveloped Areas", Journal of Farm Economics, November (1951)

^{5/} Gilson, J.C., Strengthening The Farm Firm, Agricultural Economics Bulletin No.6, Department of Agricultural Economics, University of Manitoba, April (1962)

Another unique feature of the family farm is the "biological cycle" through which it goes once every generation. It starts with the beginning farmer, adjusts and modifies with his growing family and eventually ends with his retirement. The farm is then passed on to the son who in turn goes through the same type of cycle during his lifetime on the farm.

(11) The economic structure of the family farm varies tremendously in Canada. The typical commercial farm in Western Canada, for example, may have a total capital investment ranging from \$50,000 to \$75,000, of which \$5,000 to \$15,000 will be borrowed capital. Total annual operating expenses for the farm business may range from \$7,500 to \$15,000. The farm may include from 320 to 640 acres of land under cultivation. However, variations will occur in both directions from the so-called "typical" commercial farm. It is not uncommon to find family farms in Western Canada with a capital investment of from \$100,000 to \$200,00. And at the other extreme, family farms in the less developed regions of the country may have a capital investment as low as \$15,000 to \$20,000, with the families on such units deriving a large part of their livelihood from home-grown consumption.

(12) Technological developments have had several important effects on the individual farm business. Perhaps, one of the most difficult problems facing the farm manager in Canada is that of finding the best "product-mix" or enterprise combination for his particular farm business. Continuous changes in prices, markets, technological developments and countless other forces which impinge on the farm business dictate corresponding changes in the production practices and enterprise combinations which will be most profitable for any given farm. Technological efficiency by itself is no guarantee of business success. Farm management studies have shown repeatedly that many farmers will be doing an excellent job with a given enterprise on their farms, but will be losing money because such an enterprise is not the right one for their particular farm unit. Farming in Canada is more than a production plant. It is a business. The primary criterion of success is the level of living which each operator derives from his farm.

(13) Another problem facing the Canadian farmer is the continuing need for an increase in scale or size of farm business to justify the adoption of many of the technological innovations which are available. Many farmers simply do not have a size of business large enough to justify the use of a particular production practice, regardless of how profitable it might be to the larger firm. To date the individualism of the Canadian farmer appears to have prevented the widespread practice of jointly sharing or owning costly machinery and equipment as an alternative to expanding the size of business. This is an area which would bear considerable investigation.

(14) Another important consideration at the individual farm level is the increasing tendency towards greater specialization. The increasing complexity of the farming operations, the economies of scale associated with a large volume of business, and the demand by the Canadian consumer for a uniform and high quality product have all placed a greater premium on specialization within the farm business. A great many farms in Canada are too highly diversified to achieve the economies and efficiencies associated with specialization.

(15) One of the more important results of the technological revolution in agriculture has been the increase in capital investment in the farm business. It is estimated that it requires control over a minimum of \$30,000 in Manitoba to start farming, part of which will be borrowed capital. Studies have indicated that it is almost impossible for the young man to start farming without substantial help, usually from his parents. Even when the young man gets started in farming it will require at least \$50,000 before he can be assured of an economic size of farm business; and this figure is steadily increasing.

(16) The ever increasing capital investment required to establish an economic size of farm business raises the question as to whether the individual farmer should attempt to pay for the business during his lifetime. Most farmers aspire to

a clear title to the business at the time of retirement. One wonders if this goal will be possible, or even reasonable, in the future. Perhaps, the share capital method of financing the farm business and "perpetual debt" will have to be considered.

(17) One of the more significant results of the growing size of business, borrowed capital, specialization and the increasing dependence on the market are the growing risks attached to the farm business. Farmers have traditionally built in their own forms of insurance and hedges against uncertainty through such actions as diversified farming and minimum debt. It appears that increasing emphasis will have to be placed on the more formal types of insurance programs in agriculture.

(18) Finally, and perhaps most significant of all, many farmers in Canada lack the managerial ability necessary to cope with the ever growing complexity of the farm business. No other industry in Canada requires as many managers as that of agriculture. The proprietary nature of the production firm in agriculture requires that every farmer must be a manager as well as a laborer. As important as the labor factor is in farming, it does not substitute for good management. Ways must be found to improve the management ability of many Canadian farmers if the industry is to remain progressive and responsive to continuing technological changes. This could be one of the most difficult problems we face in the years to come.

IV

(19) If the farm management specialist is to deal effectively with the many questions which are being raised by farmers and agricultural administrators in Canada, he will have to be supported by a continuing program of sound research. For some inapplicable reason it is believed by many (economists included) that solutions for the important economic problems associated with the farm business are readily available, or if not available, may be quickly obtained through farm accounts or farm management surveys. For those who have engaged in any serious research, nothing could be further from the truth. The farm management specialist must depend on a program of research every bit as tedious and complicated as that of the plant breeder or animal nutritionist. And like the fields of plant or animal science, farm management research may range from the Baconian methods of "getting the facts" to the highly deductive methods of mathematical economics. The philosophy of research is stressed at this point because not all administrators and fund granting bodies are entirely clear or sympathetic as to what is involved in the process of farm management research.

(20) It is not possible to elaborate in this paper on all phases of farm management research. Perhaps, however, it would be worthwhile to list some of the problem areas which appear to have considerable priority in any farm management research program in Canada at the present time: Extent and Nature of economies of scale associated with various aspects of the farm business; Nature of the risk and instability impinging on the farm business and alternative methods of coping with it; Processes of capital accumulation within the family farm; Investment of credit in the farm business and debt repayment capacity of various forms of investment; Various types of land tenure and implications for the farm business; Estate planning including such problems as father-son agreements, retirement plans, transfer of the farm between generations; Economic returns on various types of farm resources by geographic region and type of enterprise; Developing guidelines for the optimum combination of enterprises within the farm business; Problems associated with young farmers getting established in farming; Ways of adjusting to and accommodating various types of technological innovations within the farm business; Methods to facilitate the movement of the redundant labor resource from agriculture to other occupations.

(21) The above problem areas are only examples of what may be included in any farm management research program in Canada. The content of any research program will vary according to the training and inclination of the research worker and the environment in which he happens to be doing his work.

(22) It is the philosophy of this writer that a program of research in farm management should have a strong problem orientation. Accordingly, what will be

valuable in one country may not have any relevance or utility in another country. In working with graduate students from many of the underdeveloped countries of the world, we have observed at the University of Manitoba that there is a strong inclination for these students to develop their training along the lines of our more sophisticated research tools and techniques. They become quite conversant with such areas as linear programming and the use of the electronic computer. One wonders, however, how useful such training might be to many of these students when they engage in programs of farm management research in their own countries where electronic computers may not be readily available. This is a problem which is being closely examined in the U.S.A. at the present time.

V

(23) The extension techniques which have worked so effectively in the technical disciplines do not appear to be altogether suitable in the field of farm management extension work. In the technical disciplines the extension worker is primarily involved with the transfer from the research laboratory to the farm of single, isolated physical or biological practices. It is a "piecemeal" type of presentation of technical data to the farmer. In addition to this, the extension worker in the technical disciplines attempts to use the educational or demonstration approach involving large groups of farmers, rather than the personal service approach, in the presentation of his data. And in general, this approach has worked reasonably well.

(24) When it comes to the farm management extension worker, however, he is expected to go much beyond what is expected of the extension worker in the technical disciplines. The farm management extension worker is expected to move from the general meeting of farmers to the individual farm business. The farmer insists that if the various technical innovations are to be of any value to him they must be profitably incorporated into his particular farm business. The shift is from the piecemeal presentation of single, isolated practices to the whole farm; from the broadly educational to the personal service approach.

(25) This poses a problem for the farm management extension worker. If he is to reach the largest possible number of farmers he must attempt to deal with groups of farmers. If he is to deal in a meaningful way with many of the problems of the individual farmer, however, he must work with the individual farm business. We have found in our extension work in Manitoba that the extension worker must be very alert to the possibilities of dealing, whenever feasible, with groups of farmers, rather than the individual. For example, in farm accounting work, most farmers will attempt to have the extension worker deal with them individually. We have found, for the most part however, that the group technique can be very effective in accounting work. On the other hand, there are many problems of a personal business nature which are better handled on the individual farm basis.

(26) An example of the types of problems faced by the farm management extension worker in Western Canada may be illustrated by the requests for assistance which the writer has received from farmers during the past eight years: Help to set up and analyze farm accounts; Assistance with income tax returns; Establishing workable father-son operating agreements; Problems of estate planning such as life insurance, wills, farm transfers; Use of farm credit in the business; Rental arrangements; Setting up various types of contractual arrangements in production and marketing; Plans for security during retirement; Determination of the best combination of various types of enterprises on the farm; Wage incentive arrangements with the hired man; How to get started in farming; Debt carrying capacity of the farm business; Evaluation of the future prospects of various types of enterprises; Whether to continue farming or to move to some other occupation.

(27) The above are examples of some of the problems facing the farm management extension worker in Western Canada. It is interesting to note that while some of the problem areas may be handled on a group basis, most were of a personal service nature. In general it is clear from the problems raised by farmers that a continuing program of farm management research is imperative if meaningful answers are to be found.

NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.
2. Papers selected for inclusion in Specialized Sessions will be available at the Conference in only one of the above official languages.
3. Summaries of all papers, as submitted by contributors, will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.
4. Papers and summaries will not be available for general distribution in advance of the Conference. They will be published in advance in limited quantities only for the use of delegations of participating governments and of other authorized participants. Post-Conference publication and general distribution of the Conference Proceedings will follow United Nations practices as laid down by the United Nations Publications Board.

THE ROLE OF FARM MANAGEMENT IN
RELATION TO THE TECHNOLOGICAL DEVELOPMENT
OF THE AGRICULTURAL INDUSTRY

by

J. C. Gilson

Department of Agricultural Economics
University of Manitoba

(1) The technological revolution in Canadian agriculture has had profound and far-reaching implications for the individual farmer and his rural community. It has called for economic and social adjustments for which many farmers in Canada have not been adequately prepared. Technological advance has created a complex, highly capitalized business unit for which many farmers have neither the managerial skill or finances to cope. It has transferred most of the services which farmers previously produced on their farms to the rapidly growing agri-business sector of the economy, and in the process has exposed farmers to new problems of processing, marketing and bargaining power. Technologically displaced farm people have been squeezed out of agriculture into other occupations for which they were poorly equipped.

(2) The technological revolution is moving rapidly ahead of the economic and social changes needed at the individual farm level. The gap must be closed if technological progress in agriculture is to become the full blessing which it is intended to be.

(3) Increased emphasis will have to be placed on farm management programs at the individual farm level to facilitate the adjustments which are required. Technological efficiency by itself is no guarantee of economic success. Farming in Canada is much more than a production or processing activity. It is a business - a highly capitalized and complex operation. The primary criterion of success is the level of living which each operator derives from his farm.

(4) The Canadian farmer is facing many difficult problems in his business at the present time. One of the more difficult problems involves that of scale of business. Many farmers simply do not have a size of operations large enough to justify the adoption of many of the recommended technological practices. As a result of the increasing complexity of the farming operations, the economies of scale associated with a larger volume of business, and the demand by the Canadian consumer for a uniform and high quality product, there has been a growing premium on specialization within the farm business. Increasing specialization and the growing dependence of the Canadian farmer on the market system have increased his vulnerability to risk and instability in the economy. This, in turn, has led to the need for a greater emphasis on more formal insurance programs and on public policies designed to alleviate problems of risk in agriculture. The technological revolution has caused a very significant increase in the quantity of capital needed to establish an economic size of farm unit. It has called for substantial changes in farm credit policies and has put pressure on

the Canadian farmer to make increased use of borrowed capital. It has raised the problem as to whether the rate of capital accumulation within the family farm is rapid enough to permit complete ownership of the farm business once every generation. Finally, and perhaps most significant of all, many farmers in Canada lack the managerial ability necessary to cope with the ever growing complexity of the farm business. Ways must be found to improve the management ability of many Canadian farmers if the industry is to remain progressive and responsive to continuing technological changes. This could be one of the most difficult problems emerging in the years to come.

(5) If farm management programs are to be developed which deal effectively with the implications of technological progress for the individual farmer a continuing program of research will be needed. The farm management specialist will require a program of research as comprehensive and aggressive as that of the physical and biological sciences. Indeed, it has been the sound program of research behind the physical and biological sciences which has led to the magnificent technological advances in agriculture and which, in the process, has generated many of the economic and social problems at the individual farm level.

(6) It would be worthwhile to list some of the problem areas which appear to have considerable priority in any farm management research program in Canada at the present time: Extent and Nature of economies of scale associated with various aspects of the farm business; Nature of the risk and instability impinging on the farm business and alternative methods of coping with it; Processes of capital accumulation within the family farm; Investment of credit in the farm business and debt repayment capacity of various forms of investment; Various types of land tenure and implications for the farm business; Estate planning including such problems as father-son agreements, retirement plans, transfer of the farm between generations; Economic returns on various types of farm resources by geographic region and type of enterprise; Developing guidelines for the optimum combination of enterprises within the farm business; Problems associated with young farmers getting established in farming; Ways of adjusting to and accommodating various types of technological innovations within the farm business; Methods to facilitate the movement of the redundant labor resource from agriculture to other occupations.

(7) A program of farm management research must be complemented by an effective extension policy if the fruits of research are to reach the individual farmer. The extension techniques which have worked so effectively in the technical disciplines do not appear to be altogether suitable in the field of farm management extension work. In the technical disciplines the extension worker is primarily involved with the transfer from the research laboratory to the farm of single, isolated physical or biological practices. It is a "piecemeal" type of presentation of data and information to the farmer. When it comes to the farm management extension specialist, however, the farmer insists that if the various technical innovations are to be of any value to him they must be profitably incorporated into his particular farm business. The shift must be from the piecemeal presentation of single, isolated practices to the whole farm approach. Farm management extension work tends to be a highly individualized, service type of operation. One of the greatest problems facing the farm management extension worker is the necessity of dealing with the individual farm business and at the same time reaching as many farmers as possible with the limited resources of time and money at his disposal.